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THE CHEMISTRY OF THE FUTURE[1]

IT is interesting to speculate on what chemistry will be like fifty years from now. We may be sure that hydrochloric acid will neutralize sodium hydroxide just as it does now, and did half a century ago, and that the two will react in precisely the proportions that they have in the past. No doubt within fifty years the two isotopic hydrochloric acids will be available in small quantities in the pure state, but I am thinking now of the practical hydrochloric acid, the one that our fathers used before us and our grandchildren will continue to use in the laboratories and plants. By all this I mean, as you will understand, that the fundamental facts of chemistry will still be valid at the end of the next half century. Of course, that must be, for facts, defined as "the direct result of observation unmodified by any act of reason," are eternal. All our facts will be there but with what an enormous mass of new ones! Instead of a few hundred thousand compounds of carbon, we will have them literally by the millions. Inorganic chemistry will not be so bad, but with the extension of water, ammonia, sulphur dioxide, acetic acid, phosphorus oxychloride systems of acids, bases and salts and the natural development of the subject, the substances to be studied and facts to be learned about each will be enormously increased. Physical chemistry—my! and colloids, radioactivity, thermodynamics, phase rule and unborn nameless chemistries, each with a literature running into thousand upon thousand of pages. Pity! oh, pity, the poor student of fifty years from now and pity, too, the teacher.

How can all this be taught and learned? Well, the physicians are adding so rapidly to the average span of life that our grandsons can well afford to spend more time in preparation, particularly since the physiological chemists of that age will in a large part have solved the problem of prolonging our years of activity. The educational experts will doubtless contribute by shortening the period of preliminary training because it is inevitable that some good must come of all their feverish activity and to some of us seemingly wild unordered experimentation. But when students reach the university unable to use a dictionary because they were not taught the alphabet,

[1] Address of the retiring vice-president of Section C—Chemistry, American Association for the Advancement of Science—Philadelphia, Pa., December 28, 1926.

unable to multiply because the multiplication table was omitted, not knowing what a proportion is and thinking a ratio is something to eat, it can be easily seen that some of the present efforts are not in the right direction. Progress will be greater as pupils, parents and teachers learn that learning is proportional to the effort and that workless schooling will not work.

The chief reliance must, of course, be placed as in the past upon the most careful selection of fundamental facts and basic principles and their logical presentation and coordination with the aid of the best theories at hand. It is in the theories that we will probably find the greatest difference between the chemistry of to-day and that of the future. The facts remain, but their theoretical interpretation changes and with it comes change in language, so if we, in the turn of a hand, could go from here to a lecture on general chemistry in 1976, we would no doubt have great difficulty in understanding the speaker.

How are the theories going to change? We can only judge from the past. As you know we first have a chaos of apparently unrelated facts, then an inspired idea which, with the added hypotheses, reduces the confusion to comparatively simple unity, in which all the facts are naturally fitted and coordinated in such a way as to make their retention by the memory comparatively easy. The theory predicting new facts leads us on and on and frequently rewards us with new discoveries which almost fit the predictions but differ enough so that the theory clearly must be revised from time to time to make it agree with the stubborn facts. With these changes it always becomes more and more complex until at last it is really burdensome, although fully able to account for nearly all the facts very satisfactorily. Then some man with the genius of Copernicus appears and explains all the old and some of the new facts in a radically different and very much simpler manner. Many of our present theories are rapidly approaching the unwieldy stage. Take the atomic, for example, for a long time the model of simplicity. But now how complex! The perfectly elastic atom of our daddies transformed into a cosmos of protons and electrons revolving in a maze of actual and potential orbits, shooting from one orbit to another with the radiation of quanta of energy. Lucky dad, you did not have to worry about hν. Your element gave its spectral lines for the same reason that the hen ran in front of a car—because it did and that was the end of it. Good work, son, your idea is much better than our old awkward hν. Keep on, you are getting to the root of the matter now, but remember that your son is going to dig it all up and throw it away.

The atom of the physicist is very enticing with its marvelous accord of fact and fancy as guided by the quantum theory, electron theory, relativity theory, etc. The chemist of the present and much more of the future must be an able mathematician to take advantage of all this. Useful as this atom is in the physical laboratory, it is of but little service at present to the chemist, but perhaps it can be used to explain the puzzle of why a substance which undergoes a monomolecular reaction does not all change in an instant, instead of a perfectly definite fraction undergoing transformation per unit of time. We can picture to ourselves that the atom is perfectly stable until the electrons have dropped into some one definite set of orbits, when the atom immediately becomes reactive and undergoes the change. Perhaps also the same notion can be extended to cover the rapid increase in rates of reaction with rising temperature.

If there is anything to this idea the system should radiate energy way down in the infra red because the electron changes are probably in the very outlying orbits. In the case of the radioactive elements which follow the monomolecular type of change the sensitizing electron shift must lie within the nucleus because it is evident that the nucleus is the seat of the alpha, beta and gamma rays. This difference in the location of the orbits may perhaps account for the indifference of radioactive changes to alteration in temperature. Electron shifts between orbits lying within the nucleus should give rise to radiations of very high frequency and this may perhaps account for the gamma rays. No doubt some of the attempts which are being made to reconcile the Bohr-Sommerfeld atom of the physicist with the Lewis-Langmuir cubical atom of the chemist will soon succeed and give us an atom suitable to the needs of each. This atom may perhaps be tetragonal instead of cubical. The basis of this suggestion is the result of a recent conversation with our crystallographer, Dr. Knight. He found difficulty in finding crystals of the cubic system with the necessary development of faces to give corners for the electrons in the positions demanded by some of the elements of high atomic weights. But we found that the requirements can be easily met in the tetragonal system. Now when you come to think about it, the two electrons in the K position will naturally lie along some one axis and should make this different from the others, leading almost inevitably to a tetragonal system.

By the time we get these atoms working satisfactorily to all concerned and have taken care of the growing idea that both electrons and protons are complex we will have a truly marvelous universe in miniature. I am very sure that you will agree with me that simplicity and not complexity is evidence of

genius and I for one can not believe that the supreme Genius, the Deity, would make anything as complex as a Bohr-Sommerfeld-Lewis-Langmuir atom would be. Some say that these are not complex, being made up of simple electrons and nuclei, but a glance at Sommerfeld's picture of the xenon atom shows it to be incredibly complex, so we may confidently expect that some young man will play the part of Copernicus and give us an entirely new, beautifully simple theory in place of our creaking atomic theory and all its attendant fancies. Then for a while our children's children may have an easy time until this theory has lost its beautiful smoothness from the lumps raised by its hard knocks on unyielding facts.

The advent of such a theory would doubtless be followed by a renaissance of chemistry similar to that which recently changed the physicists from placid seekers for the fourth decimal into eager pioneers straining every nerve to reach some portion of the fertile field of knowledge which the recent theories laid open to their astonished view.

Radioactivity having established that elements change spontaneously into other elements, it is, of course, inevitable that we shall find out how to do the trick. Perhaps some of the reports of transmutation such as those of mercury and gold may prove to be correct. The reported change of hydrogen into helium is more credible than some of the others because it should take place with the evolution of energy. Such transmutations may be taught as a matter of routine in general chemistry within the next few years, let alone the half century, being illustrated in lecture demonstration in which the process is carried out in a few moments' time under the very eyes of the class, and while it is going on some budding engineer or premedic will go to sleep, considering it not spectacular enough to be interesting. Of course, the production of hydrogen nuclei from aluminum is now commonplace and may be demonstrated to the eye or ear of a large audience.

Physical chemistry will doubtless be very different; for one thing we must turn our attention to concentrated solutions, to the things that we actually use. Intensive study of these must yield results the reaction of which will be far reaching. These investigations will call for all the aid which thermodynamics, mathematics and physics can give the chemist. Of course, great advance will be made in other lines also and we will soon have more and better data on all the important physical constants of our almost innumerable substances. The new theories will certainly open up many lines for investigation.

I am sure we all expect that within the next few years catalysis will so far yield its secret as to lead us to a good working hypothesis which will enable us to make predictions with reasonable assurance of their fulfilment.

Will colloid chemistry be supreme fifty years from now, as some of its advocates seem to think, or will it be merely a very important part of chemistry, as the most of us believe? I am willing to see colloids in the soup, the salad, the jello with the whipped cream of dessert, but I am going to insist that the mineral water is a "true" solution.

The good old phase rule, famed for its simplicity and because of its freedom from assumptions concerning the molecular state of its working substances, is now showing signs of maturity because some of the old standard one component systems are behaving in such a way as to indicate that they have to be considered pseudo binary or ternary systems with all the attendant complications. Even so the more intensive study of alloys which is now beginning will, largely under the direction of the phase rule, so expand our knowledge that we will doubtless be able, in a very great measure, to predict the properties of alloys and to produce metallic materials having almost any desired properties.

The changes in organic chemistry will probably lie in a great increase in the number of compounds of our familiar types with a comparatively small increase in compounds of new types, although this latter statement is subject to revision. There will certainly be a great extension of applications of physical chemistry to organic chemistry, with advantages to each. X-ray analysis will, of course, be largely used as a guide to structure. Electron theory of valence and other valence theories will be of great assistance. Along this same line the study of the potentials of voltaic cells with organic active materials will yield important information. Organic syntheses of essential industrial materials, such as rubber, oil, etc., are growing now, as every one knows, by leaps and bounds and must make us in the future at least partially independent of the natural processes and stores of such substances. Parallel to this will come the discovery of means to improve the natural processes for the production of such substances through better agriculture and more efficient handling. Most of this is interlocked with the development of our knowledge of catalysis. Some one is going to bring about the frequently announced photosynthesis of carbon compounds. You have probably been impressed by the fact that each worker in this field is doubtful of the success of others. The fact that compounds of nitrogen, phosphorus, etc., are essential to the life of living plants suggests that perhaps the first step is the production of compounds containing some of these elements and carbon, say of the type HCN, with their subsequent reaction with water and polymerization to

form carbohydrates. If this view is correct, the addition of proper compounds of these elements to a carbon dioxide water system should catalyze the photosynthesis of carbohydrates.

We are all looking forward to most spectacular advances in the overlapping fields of organic chemistry, physiological chemistry and medicine. Modern miracles are happening every day. I suspect that most of us could find in our immediate families or among our close friends individuals alive and in good health who a short twenty-five years ago must have taken the long journey in spite of all the aid which even the best of science could have given them. We may be certain that in our own time man's years of comfortable, happy, useful life will be greatly increased, and what more can we ask of chemistry than an enlarged opportunity to be of service to our fellows?

H. P. CADY

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SHORELINE INVESTIGATIONS ON THE ATLANTIC COAST

IN the course of researches on the supposed progressive subsidence of the Atlantic coast it has been discovered that many of the apparent changes of level were in fact caused by local fluctuations of the high tide surface due to changes in the form of the shoreline. As low tide levels are likewise known to vary with variations in the form of the shore, but as a given shore change does not necessarily produce equal or equivalent changes in the high tide and low tide levels, the question arises as to whether mean sea level itself may not change with changes in the form of the shore. It has generally been assumed that mean sea level, when determined by accurate observations extending over a long period of years, is essentially a constant plane; and differences of mean sea level as determined at different periods have been held to prove progressive submergence of the coast; while differences determined at different localities at the same time have been ascribed to errors in tide gauge readings or computations, or to errors in levelling. It seems possible that these observed differences of mean sea level may have been correctly determined and represent merely the fluctuations of an irregular surface, the inequalities of which vary, both from time to time and from place to place, with variations in the form of the shore.

The importance of determining whether mean sea level is locally an irregular surface (aside from the broader inequalities known to exist due to gravitative attraction of mountain masses, direction of ocean currents and other causes previously studied,) and whether it may change to an appreciable degree and with rapidity consequent upon changes in the form of the shore, is obviously very great. Many of the supposed proofs of a recent and continued subsidence of the Atlantic coast of North America can be interpreted as due to local fluctuations of high tide level amounting in cases to as much as several feet. Proof of subsidence, if it exists at all, must be based on a comparison of mean sea level observations made at different periods; and it is clear that the necessary evidence can be regarded as reliable only as it be demonstrated that changes in shore form do not affect the position of mean sea level. At present all arguments for changes in the relative level of land and sea based on observed changes of mean sea level are open to suspicion.

The altitudes of the official benchmarks throughout the country referred to mean sea level are calculated on the basis of tide-gauge records obtained in localities many of which are apparently favorable to local fluctuation of the high and low tide surfaces, and hence possibly of the mean sea level surface. This results from the fact that tide gauges are most conveniently located in bays, harbors or other protected re-entrants in the coast, the very places most subject to fluctuations of tidal levels. If neither accurate tide-gauge observations extending over long periods of years nor the most precise levelling from gauge to permanent benchmarks gives results of permanent value because a gauge is unfortunately located, this fact should be known.

It is not alone the scientific investigator, the surveyor and the geodesist who have a vital interest in this question. Every owner of property bordering the sea has an actual or potential interest of no mean importance. Where waves are attacking the coast, the value of property may in considerable measure be determined by the probable future rate of coast erosion, and the consequent nature and expense of the protective engineering works required to check the inroads of the sea. Even the title to ownership of property may hinge in part on rates of erosion in the past, as has been demonstrated in recent cases in litigation. In all such cases the question of possible changes of sea level needs to be taken into account; for if this coast is subsiding at the rate of one or two feet per century, as many geologists have believed, the erosion will be much more vigorous than if the coast is stable. Other cases have arisen in which title to valuable property has depended directly on whether or not the land has subsided.

The aspects of the case briefly outlined above could readily be developed at greater length, but enough has been said to indicate both the scientific importance and the practical value of the results to be obtained

from an authoritative experimental determination of the facts at issue. Some time ago the matter was presented to the director of the United States Coast and Geodetic Survey, who expressed interest in the project and promised the cooperation of the survey to the limit permitted by existing laws and appropriations. The Division of Geology and Geography of the National Research Council undertook to secure necessary funds and to arrange if possible for the cooperation of certain other government bureaus and private individuals in a careful study of the nature and variations of mean sea level at selected points along the Atlantic coast. A Committee on Shoreline Investigations was appointed, consisting of Isaiah Bowman, N. M. Fenneman, R. S. Patton, and the writer as chairman, this committee being charged with perfecting plans for a study of mean sea level variations as affected by shoreline changes and with the prosecution of other shoreline studies. The following discussion is based largely on the report of the chairman of the committee presented at the last annual meeting of the division and sets forth the present status of the operations.

Correspondence with the chief hydrographer of the Canadian Hydrographic Office has led to a tentative promise of assistance from the Canadian authorities, provided the expense involved does not prove prohibitive. The region of St. John, New Brunswick, seems to offer exceptionally favorable conditions for comparing the mean level of the sea with that of a large embayment (Kennebecasis Lake) connecting with the ocean by an extremely narrow inlet and receiving great quantities of fresh water. The tidal range is great, twenty to twenty-five feet, while the distance over which a line of precise level would have to be run to connect a gauge in the embayment with one in the outer harbor is small. A line of levels, possibly of adequate precision, has already been run between St. John on the harbor and Rothesay on the lake. A tide gauge has long been maintained in the harbor at St. John and it is hoped that the Canadian authorities will establish a gauge in the lake and operate the two simultaneously for one year as an aid in the committees' investigations.

Conferences with the chief engineer and with the division engineer in charge of tidal observations, of the Department of Docks of New York City, resulted in an offer on the part of the department to operate three or four tide gauges in Jamaica Bay near New York City for a period of one year, providing the committee could secure the loan and installation of gauges of suitable type, and could further arrange to have the gauges connected by lines of precise level. The chief engineer of the Department of Plants and Structures of New York City has expressed a willingness to cooperate in the matter of securing proper installation of the gauges, while the United States Coast and Geodetic Survey has agreed to loan the necessary number of instruments. Further details of cooperation are being worked out under the active direction of Commander G. T. Rude, of the Coast Survey. Jamaica Bay offers special advantages for the study in hand. The adjacent region is covered by a network of lines of precise level surveyed with a high degree of refinement under direction of the New York City Board of Estimate and Apportionment from 1909 to 1914. The tidal range is moderate (four to six feet); the channel connecting with the open sea is fairly wide, while the amount of upland water entering the bay is negligible, thus offering in three important respects a useful contrast with conditions in the St. John area.

Dexter P. Cooper Incorporated, of Eastport, Maine, has agreed to operate, for a period of one year, three or four tide gauges in the vicinity of Eastport, Maine, including the arms of Cobscook Bay. Mr. Cooper has also generously agreed to carry out the precise levelling required to connect the gauges, which here must be widely separated in a region where no lines of precise level have been run. At Eastport the tidal range is great, eighteen to twenty feet, and there are broad bays connecting with the ocean by narrow inlets. The fact that the region is one involved in a large scheme for utilization of tidal power adds interest to its selection as an appropriate site for mean sea-level studies. If the proposed engineering works for controlling tidal waters are installed here, further tidal observations during their construction would reveal any changes in mean sea level due to progressive interference with the tidal régime in bays and channels gradually blocked by the building of dams.

A competent officer of the Division of Tides and Currents of the United States Coast and Geodetic Survey has approved the committee's selection of the three localities described above as being well suited to the purposes of this investigation. Preparations for the Jamaica Bay study are well advanced and five tide gauges will be installed in Jamaica Bay and adjacent localities during the latter part of October. The observations at Eastport must wait, apparently, until the Coast Survey can free a sufficient number of its larger tide gauges for the work. Final decision on the St. John project is awaited from the chief hydrographer of Canada. If the tidal studies projected for the New York, Eastport and St. John regions can be carried to completion on the basis above indicated, they should make possible definite conclusions as to the nature and extent, if any, of local variations in mean sea level due to variations in the form of the shore.

In the opinion of the committee an important phase of its activities should be to promote the securing and recording of full and accurate information regarding changes in the form of our shorelines resulting from erosion and accretion, or from variations in the relative levels of land and sea due to either local or general causes. Such changes not only result in frequent and serious damage to public and private property, bringing heavy charges upon taxpayers and property owners, but they precipitate legal controversies, the solution of which depends upon a proper understanding of the changes and their causes, and they necessitate costly shore protection works for the proper construction of which the engineer demands a fuller knowledge of shore changes than is now available to him. The committee brought to the attention of the United States Coast and Geodetic Survey the importance of having its field parties make and record in their field reports accurate measurements of the distances between permanent marks established on the coast, and changing elements of the shore, such as high water line, top of beach slope, crest of cliff and other easily recognized shore features. In response to this representation the survey issued to its field parties special instruction for the making and recording of the desired measurements.

As a further step in the direction of securing fuller knowledge of shoreline changes, the committee, confining its attention for practical reasons to the Atlantic Coast,[1] has addressed to geologists, geographers and engineers (including appropriate state and municipal authorities) in the Atlantic and Gulf coastal states a circular letter emphasizing the economic value of natural and artificial beaches, the practical importance of their adequate protection and the lack of precise data required by marine engineers for the proper installation of protective devices; and requesting information regarding shoreline conditions and shoreline studies in each coastal state.

The committee also addressed a similar letter to the chiefs of the Coast Guard and Lighthouse Services, and requested the chiefs of these services to circulate among their officers and employes stationed on the Atlantic and Gulf coasts a carefully prepared questionnaire, designed to elicit information regarding shoreline changes taking place under the observation of men whose regular duties give them special facilities for noting the variable effects of waves and currents. It is the thought of the committee that replies received from both letters and questionnaires will serve to indicate more clearly the directions in which further steps can most profitably be taken.

As a contribution to the work of the committee the chairman assigned certain shoreline problems to a limited number of graduate students in physiography. W. D. Burden completed a study of shore changes on Gardiners Island and parts of the northern coast of Long Island, in which past rates of coast erosion and successive positions of the shoreline are considered at some length. E. I. Winter has made a study of variations in mean sea level in the course of which much data useful to the committee were assembled. H. S. Sharp carried out an examination of artificial beach construction along the New York and Connecticut shores, with a view to determining certain of the physical factors favorable to and unfavorable to enterprises of this type. O. Kuthy collected and analyzed published data on elevated beaches in order to determine how far such data may properly be used as evidence of sea-level changes as distinguished from changes in the level of the lands. D. A. Nichols is engaged on a study of the evolution of the southern shoreline of New Jersey, this work being prosecuted with support from the Geological Survey of New Jersey. In the opinion of the committee the results already obtained from these studies justify the belief that investigations of shoreline phenomena at various points along our coast, carried on by properly qualified and directed graduate students, can be made to contribute substantially toward the objects which the committee has in view, both by discovering and making known facts of shoreline changes, and by directing public attention in an increasing measure to the importance of shoreline problems. With a view to furthering studies of this type the committee decided to get in touch with professors of geology and geography in our coastal states, and to ascertain to what extent they would be willing to encourage shoreline studies by competent students under their direction.

The committee believes that there is much need of an enlightened public opinion to demand and support intelligent action by governmental agencies—federal, state and municipal—in dealing with the protection and development of our shores. In Great Britain, Holland and other countries the burdens which coast erosion throw upon the taxpayer are better understood, and support for constructive action by public authorities has not been lacking. Our people must be made to realize that loss of coastal land in the long run becomes a charge upon them, whether or not they live upon the shore. They must understand the advantages which may be enjoyed by the whole public if their representatives take proper steps to protect existing beaches and to create new ones.

[1] A Committee on Features and Changes of the Shoreline of the Pacific Coast has since been formed in the Division of Geology and Geography of the National Research Council.

As an aid toward arousing a wider and more intelligent public interest in shoreline problems and to collect information of possible value concerning shoreline phenomena, the committee is asking all who are interested in the work to communicate to the committee information on the following points:

(a) Changes in the shoreline (backward cutting, forward building, shifting of inlets, etc.) now in process of taking place, or which have taken place very recently. Precise data, or the names of reliable persons able to give precise data, are particularly desired. Photographs, especially photographs taken at intervals from the same viewpoint, are valuable in showing cliff retreat under wave attack, the progressive growth of bars and sandspits, the erosion of beaches and the destruction of seawalls, houses and other artificial structures.

(b) Engineering works now in process of construction for the protection of shore cliffs or beaches, for the maintenance of inlets or channels across beaches or bars, or for any other purpose which will involve a checking or changing of the natural operation of waves or currents along the coast. Information as to the purpose of the works in construction, with addresses of engineers or contractors in charge of construction, will be especially valuable.

(c) Completed engineering works that are of especial interest, either because they have proven unusually successful in accomplishing their purpose, or because they have signally failed to achieve the results for which they were designed. Addresses of engineers, contractors or other authorities who can furnish reliable detailed information are particularly desired.

(d) New beaches created by artificial means, whether completed or in process of development. Photographs or sketches showing original condition of the shore and its appearance after the new beach was formed, together with information as to conditions of wave and current action in the vicinity and the degree of success obtained in securing a satisfactory beach will be useful. The addresses of engineers, contractors or others in charge of the development work are desired.

(e) Addresses of individuals or organizations willing to cooperate with the committee by measuring and recording shoreline changes in their vicinity, by photographing rapidly changing shorelines at stated intervals, by observing the behavior of waves and currents on their parts of the coast in different seasons, or by loaning the committee photographs, sketches, engineering drawings, unpublished reports or other data throwing light on shoreline changes and the results (whether satisfactory or not) secured by shore protection and improvement works will be most welcome.

Communication may be addressed to the present chairman of the committee, Commander R. S. Patton, United States Coast and Geodetic Survey, Washington, D. C., or to the undersigned.

DOUGLAS JOHNSON

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FRANK HALL KNOWLTON

AT the close of a distinguished career it is quite impossible to separate the influences of heredity and environment, but both were certainly united in making a naturalist of Frank Hall Knowlton. His ancestors were of that sterling old Vermont stock which originally settled that region. He was born at Brandon, Vt., on September 2, 1860. At Middlebury College where he arrived in due season he came under the influence of Ezra Brainerd and Henry M. Seely, those distinguished naturalists who taught all the sciences and collaborated on the difficult problems of geologic research among the older rocks of that region. Their influence on the lad can not be doubted.

Knowlton's earliest interests were ornithology and botany and he retained these undiminished through life. In his early days in the West for the Geological Survey he collected recent birds and plants as well as fossil plants. The wonderfully isolated lignites of Brandon, unique in all New England, with their great variety of curious Eocene fossil fruits, must also have early stimulated his imagination and he returned to their study in his later years. In 1884 Middlebury gave him the B.S. and three years later the M.S. degree.

Knowlton came to Washington in 1884 in connection with the preparation of the U. S. National Museum exhibit for the Cotton Centennial Exposition at New Orleans, remaining afterward at the museum on a slender salary, first as aid and then as assistant curator. When Lester F. Ward was placed in charge of paleobotany by Major Powell, then director of the survey, Knowlton was made one of his assistants being employed in collecting fossil plants in the summers and studying the anatomy of fossil woods during the winters, his first work of this kind being on the woods and lignites of the Potomac formation. In 1894 he was appointed assistant paleontologist on the U. S. Geological Survey, and in 1907 he was advanced to the rank of geologist.

For nine of his earlier years in Washington he was professor of botany in Columbian (now George Washington) University, from which he received the

Ph.D. degree in 1896. In 1897 he founded *The Plant World* and was its editor for seven years. Official salaries were low and Knowlton was forced to do a vast amount of routine botanical work at that time for the Century, Standard and Webster's dictionaries and for the Jewish Encyclopædia.

Knowlton's youthful interest in ornithology culminated in "Birds of the World," published by Holt in the American Nature Series in 1909, a great up-to-date work of 873 pages, 236 illustrations and 16 colored plates, eloquent of the insight with which he had followed the expanding knowledge in all of the phases of avian study. Throughout those earlier years Knowlton was active in the meetings of the various scientific societies in Washington and held office in many of them. He was elected a fellow of the Geological Society of America in 1889, and was a charter member of the Paleontological Society and one of its first vice-presidents, serving as president in 1917. In 1921 his youthful alma mater conferred on him the degree of Sc.D.

As he came more fully into his powers a long series of memoirs on Mesozoic and Cenozoic floras flowed from his ever-active pen, and each winter season he reported on literally hundreds of collections of fossil plants made by the various survey field parties. Nor was this all—many ambitious works were partly completed and had to be laid aside because of more urgent duties, remaining unfinished.

Knowlton's health was never robust and only his great love for his work can account for an industry that was the marvel of all who knew him. It is too soon to attempt an evaluation of his contributions to science, but no one can gainsay that his keen chronologic sense has served in large measure to remove the prejudices with which his predecessors had handicapped paleobotanical studies.

For many years the Knowltons lived at Laurel, Maryland, and he was never happier than working in his garden or dispensing hospitality to his many scientific friends. A few years ago they moved to Ballston, Virginia—an easier journey from the museum. Knowlton's interests were broad—all phases of human activities—scientific, religious, political—were the themes of the lunch hour. He held decided opinions and was forthright in his likes and dislikes, but a kindlier spirit never lived, and he was never too busy or too ill to counsel and help his colleagues.

In 1913 we spent a memorable summer in the Rocky Mountain states, and Knowlton did not again go into the field until the past summer. This year he made a trip to the Pacific coast, collecting a large amount of material from the Puget group and the Spokane lake beds. The summer had been unusually good, but in November his chronic enemy, asthma, necessitated his remaining at home, as it had so often in the past, so that neither family nor friends were prepared for the end which came suddenly on November twenty-second, and was due to heart failure. He is survived by a sister, his devoted wife and two grown children—a son and a daughter.

E. W. B.

SCIENTIFIC EVENTS

PROGRAM FOR THE EXPANSION OF THE MEDICAL SCHOOL OF THE UNIVERSITY OF PENNSYLVANIA

AN extensive program for the expansion of the medical school and the hospital of the University of Pennsylvania has been announced by Dr. Alfred Stengel, professor of medicine at the university and chairman of a committee arranging for a conference on January 10 to discuss the subject.

Some of the objects included in the program are the establishment of an "out patient" department; erection of a hospital with 1,000 beds and a staff of 100 internes and 500 nurses, and the establishment of a "medical press," which would issue pamphlets on the latest developments in medicine and surgery for the information of the public.

As goals for immediate action Dr. Stengel suggested the establishment of the Martin Maloney medical clinic, provided for under the terms of a gift of $250,000 by Mr. Maloney; further development of the Henry Phipps Institute for the study and treatment of tuberculosis, in accordance with a gift of $500,000 from the Phipps family, an additional $500,000 to be raised by the university; establishment of a Philip Syng physical foundation, with an endowment of $500,000 as an adjunct to the department of surgery, and the establishment of a Joseph Leidy chair of anatomy.

The plans call for the erection of suitable buildings for the housing of these clinics. Each separate medical and surgical specialty would have a chief who would also be the senior professor of that subject in the medical school.

Plans are to be discussed at the coming conference, at which Dr. Hubert Work, secretary of the interior, and Dr. Henry S. Pritchett, president of the Carnegie Foundation, will be among the speakers.

RESEARCH IN PURE CHEMISTRY AT THE MELLON INSTITUTE

ACCORDING to a statement by Dr. Edward R. Weidlein, director of the Mellon Institute of Industrial Research of the University of Pittsburgh, there has been established in the institute a definite department of research in pure chemistry, with Dr. Leonard H.

Cretcher as the head. As a senior fellow of the institute, Dr. Cretcher (A.B., Michigan, 1912; Ph.D., Yale, 1916) has been in charge of the institution's fundamental chemical studies since 1922, and has published jointly with several assistants and other members of the institute a number of papers on the results of their organo-chemical researches.

As head of the new department, Dr. Cretcher will have supervision over all investigations in pure chemistry and will also serve as an adviser to industrial fellows who are carrying on research on problems in synthetic organic chemistry. Dr. Cretcher's activities will be operated as an integral part of the institute and will be sustained by institutional subsidy. Dr. William L. Nelson (B.S., Trinity, 1920; Ph.D., Pittsburgh, 1926), who has been named as the first fellow in the department, was a member of the staff of the department of chemistry of the University of Pittsburgh during the period 1922–26.

Dr. Weidlein states that while Mellon Institute is primarily an industrial experiment station, it has always recognized the need of fundamental scientific research as a background and source of stimulus for investigation on behalf of industry. During the past five years the institute has been giving a constantly increasing amount of attention to the encouragement and support of research in pure chemistry, and has been progressively successful in arranging for funds to devote to the prosecution of investigations not suggested by industry, but planned within the institute and aimed towards the study of more basic problems than those usually investigated for direct industrial purposes. In the institute's new department of research in pure chemistry this interest and work will be nurtured and given opportunity to expand.

THE AMBROSE SWASEY PROFESSORSHIP OF PHYSICS

As has been noted in SCIENCE a chair in physics at the Case School of Applied Science has been endowed by Mr. Ambrose Swasey. On December 19, his eightieth birthday, he sent the following letter to Case School:

For many years, as you know, I have been greatly interested in your institution and those who have been responsible for its progress and the high standard of its work.

As the years have gone on I have been especially attracted to the department of physics and the splendid men who are known throughout the world because of their work in scientific research.

It gives me much pleasure to advise you that I have to-day set over to the Cleveland Trust Company, securities amounting to one hundred thousand dollars ($100,000) as an endowment fund for a chair of physics at Case School of Applied Science. It is my belief that in the future, as in the past, your institution will render a great service for the benefit of science and engineering.

This is the second valuable gift which Mr. Swasey has made to Case School. A number of years ago he and his partner presented to it the Warner and Swasey Astronomical Observatory with its complete equipment. The first gift indicated his interest in astronomy and this second gift shows his interest in physics.

Mr. Swasey was one of the founders of the American Society of Mechanical Engineers and is a past president as well as an honorary member of that institution. He is also a member of the American Philosophical Society and the National Academy of Sciences. The state of Ohio has but two members in the academy—Dr. Swasey (for the doctorate has been conferred upon him by several institutions of learning) a member of the corporation of Case School, and Dr. Miller, professor of physics in the same college.

There are no conditions attached to this donation except that it shall be used for a chair in physics; but the trustees, in accepting the gift, have taken certain steps which they think will be agreeable to the donor. Dr. Dayton C. Miller has been appointed to the Ambrose Swasey Professorship of Physics and has been relieved of all teaching duties so that he may devote his entire time to research work.

OFFICERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A FULL account of the Philadelphia meeting of the American Association for the Advancement of Science prepared by the permanent secretary will be printed in the issue of SCIENCE for January 28. Officers were elected as follows:

President

A. A. Noyes, professor of physical chemistry, the California Institute of Technology.

Vice-presidents and Chairmen of the Sections

A—Mathematics: Dunham Jackson, University of Minnesota.

B—Physics: A. H. Compton, University of Chicago.

C—Chemistry: Roger Adams, University of Illinois.

D—Astronomy: W. S. Adams, Mount Wilson Observatory.

E—Geology and Geography: Charles Schuchert, Yale University.

F—Zoological Sciences: C. E. McClung, University of Pennsylvania.

G—Botanical Sciences: William Crocker, Thompson Institute for Plant Research.

H—Anthropology: R. J. Terry, Washington University.
I—Psychology: Knight Dunlap, Johns Hopkins University.
K—Social and Economic Sciences: W. S. Leathers, Vanderbilt University.
L—Historical and Philological Sciences: Harry Elmer Barnes, Smith College.
M—Engineering: A. N. Talbot, University of Illinois.
N—Medical Sciences: G. Canby Robinson, Vanderbilt University.
O—Agriculture: L. E. Call, Kansas State Agricultural College.
Q—Education: A. I. Gates, Teachers College, Columbia University.

Members of the Council

David White, Smithsonian Institution.
L. E. Dickson, University of Chicago.

Members of the Executive Committee

J. McKeen Cattell, New York.
H. B. Ward, University of Illinois.

Member of the Finance Committee

Herbert Gill, Washington.

Members of the Committee on Grants

W. Lash Miller, University of Toronto.
Oswald Veblen, Princeton University.

Trustee of Science Service

D. T. MacDougal, Desert Laboratory, Carnegie Institution.

SCIENTIFIC NOTES AND NEWS

THE prize of the American Association for the Advancement of Science was presented to Professor G. D. Birkhoff, of Harvard University, for his vice-presidential address entitled "A Mathematical Critique of Some Physical Theories."

SCIENTIFIC societies meeting in Philadelphia in association with the American Association for the Advancement of Science report the election of presidents as follows: *The American Mathematical Society,* Dr. Virgil Snyder, of Cornell University; *The American Physical Society,* Dr. Karl T. Compton, professor of physics at Princeton University; *The American Society of Zoologists,* Dr. S. J. Holmes, professor of zoology at the University of California; *Society of American Bacteriologists,* Dr. Robert S. Breed, professor of dairy bacteriology at Cornell University and bacteriologist of the Experiment Station at Geneva, N. Y.; *The American Anthropological Association,* Dr. Marshall A. Saville, director of the Heye Museum, New York City; *The American Psychological Association,* Dr. H. L. Hollingworth, professor of psychology, Barnard College, Columbia University.

AT the annual meeting of the Board of Directors of the Psychological Corporation, held in its offices at the Grand Central Terminal on December 2, officers were elected as follows: *President,* Walter V. Bingham; *First vice-president,* Walter Dill Scott; *Second vice-president,* Lewis M. Terman; *Chairman of the board,* J. McKeen Cattell; *Secretary and treasurer,* Paul S. Achilles; *Assistant secretary,* Elsie O. Bregman.

DR. J. J. R. MACLEOD, professor of physiology at the University of Toronto, and Dr. E. G. Martin, professor of physiology at Stanford University, will exchange courses during the months of January, February and March, Professor Macleod going to Stanford and Professor Martin to Toronto.

PROFESSOR J. H. PRIESTLEY, of the department of botany in the University of Leeds, will give a course of post-graduate lectures and demonstrations to students of the departments of botany and biochemistry of the University of California during the spring of next year. Professor H. H. Dixon, of Trinity College, Dublin, has been invited to lecture at the university during the summer months of 1927.

DR. ROGER ADAMS, head of the department of chemistry in the University of Illinois, has been awarded the Nichols medal in chemistry of the New York Section of the American Chemical Society, for his work on the Acids of Chaulmoogra Oil in the Treatment of Leprosy.

THE committee on awards of the American Society of Mechanical Engineers has nominated Wilfred Lewis as the medalist for 1927 for his contributions of research and analysis to the problem of gearing.

THE faculty of medicine at the University of Toronto has awarded the Charles Mickle Fellowship for 1926–1927 to Dr. and Mrs. George F. Dick, Chicago.

PROFESSOR W. H. HOFFMANN, of the Finlay Laboratory, Havana, has been awarded the medal "Bene Merenti" and diploma of the International Exhibition, section of tropical medicine, Rome, 1925.

THE Longstaff medal of the British Chemical Society has been awarded to Professor Robert Robinson, F.R.S., of the University of Manchester, for his "distinguished researches in organic chemistry." The Harrison memorial prize of the society was awarded to Dr. Charles Robert Harington, of University College, London. The presentation of the medal and of the prize will take place at the annual general meeting of the society on March 24.

THE gold medal of the Royal Society of Medicine was presented to Professor J. S. Haldane, director

of the Mining Research Laboratory and honorary professor in the University of Birmingham, on the occasion of the annual dinner of the society held on November 19. The medal was first awarded in 1920, to Sir Almroth E. Wright, and again in 1923, to Sir Frederick Gowland Hopkins.

THE council of the Physical Society of London has awarded the fourth Duddell medal for meritorious work on scientific instruments and materials to F. Twyman, F.R.S., managing and technical director of the firm of Adam Hilger.

THE Bavarian Academy of Sciences has elected as corresponding members Professor Harald Bohr, of the Copenhagen Technical Institute, and Professor Niels Bohr, of the University of Copenhagen.

SIR ARTHUR KEITH and Mr. C. R. Peers have been elected honorary members of the Yorkshire Philoscphical Society.

SIR JOSEPH THOMSON was entertained at a dinner in his honor held in Cambridge, England, on the occasion of his seventieth birthday on December 18.

A DINNER in honor of Dr. Lightner Witmer, founder of the psychological clinic of the University of Pennsylvania, was held on December 30 at the Hotel Pennsylvania, Philadelphia, marking the thirtieth anniversary of the founding of the clinic.

ASSOCIATES and friends gave a dinner in honor of Dr. Francis X. Dercum, for many years professor of nervous diseases of Jefferson Medical College, on December 11. Dr. Dercum celebrated his seventieth birthday last summer.

THE officers and council of the Medical Society of the State of New York will tender a testimonial dinner at the Waldorf-Astoria on January 27 in honor of Dr. Wendell C. Phillips, president of the American Medical Association, in recognition of his services to organized medicine.

FRANCIS E. LLOYD, MacDonald professor of botany at McGill University, has been elected president of the American Society of Plant Physiologists.

DR. CHARLES MACFIE CAMPBELL, professor of psychiatry at the Harvard Medical School, has been elected president of the Massachusetts Society for Mental Hygiene and Dr. Charles E. Thompson has been elected secretary.

PROFESSOR LEIGH J. YOUNG, of the department of forestry at the University of Michigan, has been appointed director of the State Conservation Department.

AT Yale University Dr. Malcolm R. Thorpe has been appointed curator of vertebrate paleontology in the Peabody Museum, and Professor George E. Nichols has been appointed director of the Marsh Botanical Garden.

DR. HENRY C. SCHUMACHER has been appointed director of the permanent Cleveland Child Guidance Clinic, which began operation on January 1, when the present Child Guidance Clinic demonstration in Cleveland closed. The position of psychiatrist which he vacates at the All-Philadelphia Child Guidance Clinic will be filled by Dr. Harry M. Tiebout, who has been on the staff of the Cleveland Demonstration Clinic.

DR. PAUL M. GIESY, until recently director of the Brooklyn research laboratories of E. R. Squibb and Sons, has resigned to engage in consulting practice, handling chemical and pharmaceutical work, in New York City.

BRIAN MEAD, of the research laboratory of applied chemistry at the Massachusetts Institute of Technology, has been appointed to a position on the research staff of the Humble Oil and Refining Company at Baytown, Texas.

EUGENE VAN CLEEF, of the department of geography at the Ohio State University, has been appointed acting chairman for the period from January 1 to October 1, 1927, during which time C. C. Huntington, present chairman, will be on leave.

DR. ALFRED N. RICHARDS, professor of pharmacology at the University of Pennsylvania, has been granted a year's leave of absence to study abroad, and is now at the National Institute for Medical Research, London.

DR. DAVID FAIRCHILD, of the U. S. Bureau of Plant Industry, left New York on December 9 for Gibraltar. The latter part of December he planned to leave Gibraltar for the west coast of Africa, where he will continue his collection and study of seeds and plants for the bureau.

DR. WILLIAM BEEBE, naturalist and explorer, sailed on December 28 for Haiti, heading the tenth expedition of the department of tropical research of the New York Zoological Society.

To continue his Arctic exploration where he left off last spring, Captain George H. Wilkins plans to leave Seattle for the north on February 12. Two airplanes, *The Alaskan* and *The Detroiter*, are stored at Fairbanks.

DR. FREDERICK P. GAY, professor of bacteriology, who is on a year's sabbatical leave, is delivering courses of lectures on the "Fundamental Factors of Immunity in the Communicable Diseases" at the Uni-

versities of Brussels, Ghent, Liège and Louvain, as American visiting professor to Belgium under the auspices of the commission for relief of the Belgium Educational Foundation.

ON December 11 Professor E. C. Jeffrey, of the botanical laboratories of Harvard University, delivered an address to the Royal Canadian Institute on the subject "New Lights on Evolution."

DR. ELIOT BLACKWELDER, professor of geology in Stanford University, delivered two lectures at the School of Mines and Metallurgy at Rolla, Mo., on December 16 and 17.

DR. HAVEN EMERSON, of the College of Physicians and Surgeons, New York, presented a report on tuberculosis in Boston at a special meeting of the Boston Health League on December 17. Dr. Emerson recently conducted a study in Boston at the request of the mayor.

DR. ALLEN O. WHIPPLE, professor of surgery in the College of Physicians and Surgeons, Columbia University, addressed the Orleans Parish Medical Society on December 13, giving the first memorial annual lecture established by the society in honor of the late Dr. Stanford E. Chaille, for many years dean of the Tulane University School of Medicine.

DR. ALFRED ADLER, of Vienna, gave a series of three lectures on December 13, 14 and 15 in the Community Auditorium, New York, on "Individual Psychology in Theory and Practice."

DR. ALBERT EINSTEIN, professor of physics at the University of Berlin, recently gave a course of lectures at the University of Leiden.

THE Huxley lecture at the University of Birmingham is to be delivered by Professor Elliot Smith on February 1, 1927.

THE Wilbur Wright memorial lecture of the Royal Aeronautical Society will be given next May by Professor Ludwig Prandtl, of the University of Göttingen.

THE senior class of the medical school at the University of Pennsylvania presented a portrait of the late Dr. Allen J. Smith to the university at a meeting in the medical laboratory on December 17. Dr. Smith was at one time dean of the medical school.

A PAINTING of Walter Reed has been unveiled at the George Washington University Medical School. Walter Reed, known for work in connection with the conquering of yellow fever, was at the time of these discoveries a member of the faculty of the George Washington University Medical School.

LOUIS SIFF, professor of mathematics at Louisville University, Kentucky, died by suicide on December 25. Professor Siff was fifty-seven years old.

DR. HENRY GUSTAV MAY, professor of bacteriology and chief of the division of animal breeding and pathology of the Rhode Island State College and Experiment Station, died on December 23 in his forty-first year.

DR. WILLIAM P. MURRAY, head of the department of ophthalmology, otology and rhinology at the University of Minnesota, died on December 27 from an infection received while performing an operation.

SIR WILLIAM TILDEN, F.R.S., formerly professor of chemistry and dean of the Royal College of Science, London, and emeritus professor in the Imperial College of Science and Technology, South Kensington, died on December 11 at the age of eighty-four years.

A JOINT meeting of the Optical Society of America and the American Physical Society will be held at New York in Fayerweather Hall, Columbia University, on Friday and Saturday, February 25 and 26. The sessions of the Optical Society will be held on Friday, those of the Physical Society on Saturday.

IT is announced that the International Union of Pure and Applied Chemistry will hold its 1927 session at Warsaw beginning on September 18.

THE centenary of the Ludwig-Maximilians University at Munich, which counted among its members Liebig, Pettenkofer and Röntgen, was celebrated last November.

THE Sigma Xi Alumni Association of the University of Pittsburgh held an open public meeting on December 16 when lectures were given by Captain Wm. Mayo Venable, of the Blaw Knox Company, on "The Sensations of Color," and Dr. H. M. Johnson, Simmons Fellowship, Mellon Institute, on "Sleep."

THE communal administration of Blankenberghe, on the coast of Belgium, has recently organized a laboratory for research in marine biology, to be associated with the University of Liège and under the direction of M. Désiré Damas, professor of zoology at the university.

THE Rockefeller Foundation has renewed, for a second period of three years, its appropriation of $40,000 to the National Committee for Mental Hygiene for the training of fellows in extramural psychiatry and psychiatric social work. These fellowships are open to physicians under thirty-five years of age, graduates of a class A medical school, who have had at least one year's training in a mental hospital.

THE Physical-Technical Institute in Leningrad has

opened a high-pressure laboratory, which is the first of its kind in Soviet Russia. It is devoted to the investigation and testing of materials and insulators and the transmission of energy. The necessary transformers have been ordered from Germany.

THE laboratories of the Banting and Best Chair of Medical Research at the University of Toronto have been moved from the medical building to the pathologic department.

THROUGH the interest of Senator James W. Wadsworth, Jr., and the cooperation of Colonel B. D. Foulois, commanding officer, Mitchell Field, State Entomologist E. P. Felt, of the New York State Museum, has arranged for systematic collection over Long Island and adjacent territory at various altitudes, with a specially devised insect trap attached to the wing of an airplane. Preliminary work has resulted in capturing two specimens at an altitude of 3,000 feet, and it is expected that considerable numbers will be found even higher in the air. It is hoped that this investigation may develop facts of importance in controlling injurious pests and explain insect movements in different sections of the world.

ACCORDING to the *Journal* of the American Medical Association, the American Association for Medical Progress has completed a survey of nearly all medical colleges and research institutions in the United States with regard to inspection by responsible visitors and the care of laboratory animals. It was found that responsible visitors are welcome at all times at these institutions. Some laboratory directors extend special invitations to officers of humane societies in order that they may observe the conditions under which animals are used for experimental purposes. All these institutions have adopted a set of rules governing the use and care of animals, which provides, among other things required, that operations be approved by the laboratory director who alone can make exceptions to the use of anesthetics, and then only when anesthesia would defeat the object of the experiment. Attached to the report of this survey is the set of rules observed by medical schools and research institutions. They require humane treatment of animals, and the return of vagrant animals to their homes when claimed and identified.

THE National Park Service has set aside an area about seven miles square in the high Sierras of Yosemite National Park as a wild life reservation. The fifty square miles are in what is known as the Hudson Arctic Alpine life zone, the elevation ranging from 9,000 to 12,000 feet. Thus far it has not been much visited by man and lies virtually in its natural state, wooded with lodge pole pine and inhabited by snowshoe rabbits, marten, fisher and other kinds of fur bearers that exist in frigid climates. The area has abundant food and water and has a rich and varied flora.

L. S. LEAKEY, member of the Cutler Dinosaur Expedition to Tanganyika, in a lecture delivered before the Kenya and Uganda Natural History Society at Nairobi on the work of the expedition in the Lindi district said that it was expected that the work would continue for five years in the hope of finding skeletons of the Dinosaur, particularly skulls, in the upper reaches of the ancient river. He announced that he was also making investigation on the Stone Age deposits of Kenya.

A COURSE designed to train professional builders with broad knowledge in both business and engineering fields has been established at the Massachusetts Institute of Technology and will start in February. The course was founded by Louis J. Horowitz, president of the Thompson-Starrett Company, of New York, through a grant from the Louis J. and Mary E. Horowitz Foundation. Professor Ross F. Tucker will give the course.

ACCORDING to the *British Medical Journal* new departments for medical entomology and biochemistry have been added to the research division of the South African Institute for Medical Research at Johannesburg, and the department of bacteriology has been extended by the establishment of a branch for plague research. Field investigations into plague have also been instituted in a camp in the Orange Free State Province. A survey of the mosquito and molluscan carriers of malaria and bilharzia respectively has been commenced. Sir Spencer Lister became director of the institute last August, when Dr. W. Watkins-Pitchford retired through ill health.

THE *Journal* of the American Medical Association states that the Paris court of appeals recently confirmed the sentence imposed on a man who made shorthand copies of lectures delivered by various professors in the medical faculty and the faculty of pharmacy and offered them for sale to the students. The deans of the two faculties brought the suit against him, but the court required the ten professors themselves to make the definite charge; each was awarded 100 francs damages, the amount asked.

UNIVERSITY AND EDUCATIONAL NOTES

DURING the past year $2,208,000 have been pledged towards the $20,000,000 fund being raised at Princeton University. This brings the total contributions to $4,587,000.

JULIUS GOLDMAN, of the New York banking firm of Goldman, Sachs and Company, has given $10,000 to the Johns Hopkins University for research in geology.

THE University of Tennessee formally dedicated its new anatomy building on December 16. At a dedicatory dinner at the Hotel Peabody in the evening the speakers were Dr. William D. Haggard, Nashville, past president of the American Medical Association, and Dr. William A. Evans, professor of public health, Northwestern University Medical School, Chicago.

DR. E. J. KRAUS, professor of applied botany at the University of Wisconsin, has accepted an appointment at the University of Chicago.

MARIE FARNSWORTH has resigned her position as research chemist for the U. S. Bureau of Mines to accept a position on the staff of the department of chemistry of the Washington Square College of New York University.

H. DARWIN KIRCHMAN, instructor of chemistry at the University of Hawaii, has been appointed instructor in chemistry at the University of California, Southern Branch.

H. MUNRO FOX, fellow of Gonville and Caius, has been appointed to the Mason chair of zoology at the University of Birmingham.

DR. R. R. MARETT has been appointed to the Frazer lectureship in anthropology at the University of Cambridge.

DISCUSSION AND CORRESPONDENCE

BOVERI ON CANCER

IN the number of SCIENCE for November 19, 1926, page 499, there is a letter from Professor Maynard M. Metcalf accusing American physicians of gross negligence because they are not acquainted with a paper of Boveri's containing some suggestions on the genesis of cancer. In the *Journal* of the American Medical Association, April 11, 1925, he printed a similar protest. He complains rather plaintively that two past-presidents of the American Medical Association, thirty professors in medical schools, several prominent surgeons and the head of an important American institution for cancer research have never heard of Boveri's work. This is indeed a sad situation, but one which should not cause too much depression in the zoological world. No one would expect past-presidents of the American Medical Association, able clinicians as they may be, to burden their minds with a theory like Boveri's. They have more important things to think of, and as for surgeons and professors in medical schools, it is far better that they should never have heard of it. It may, however, cheer Professor Metcalf to know that annually more than a thousand medical students who use Delafield and Prudden's "Text-book of Pathology" have found Boveri's theory mentioned—that is, if they read the text-book at all. And even in Professor Metcalf's own institution, Johns Hopkins, I know of a number of men who have read Boveri's brochure and relegated it to their shelves.

But if Professor Metcalf will again carefully read Boveri's paper, as I have just done, he will see that his master by no means makes the dogmatic statement quoted in the letter to SCIENCE that "studies of double fertilized sea-urchin eggs (have) established the probability that human and other animal cancer is essentially a distortion of the numerical relations of the chromosomes in the cells." Boveri himself says that the essential part of his hypothesis, and he is very careful to stress the fact that it is only hypothesis, is not abnormal mitosis, but a certain "abnormal chromosome composition (Bestand)," which may result from abnormal mitosis, and he acknowledges that it is entirely hypothetical whether, should such pathological chromosomic alterations occur, they could cause unrestricted growth of the cells affected. Boveri also frankly states that it is quite impossible with present methods to demonstrate such conditions in the nucleus as he postulates, and he confesses that he has experimented on the problem but failed to obtain any confirmation of his opinion. In other words, Boveri's hypothesis is one of those completely sterile suggestions which, however interesting they may be philosophically, permit as yet of no direct experimental approach.

I entirely agree with Professor Metcalf's general contention that many of the medical profession, including myself, are exceedingly ignorant of the finer aspects of cytology, but with full realization of the situation I have for twelve years been trying in vain to find a zoologist who would advise us how to attack the cancer problem from Boveri's point of view. All real students of the problem will, I am sure, join me in the hope of light from our zoological colleagues, and if Professor Metcalf's letters stimulate his brethren in that field to help us, they have accomplished a great purpose.

FRANCIS C. WOOD

1145 AMSTERDAM AVENUE,
NEW YORK

THE rather categorically academic assertions of Professor Maynard Mayo Metcalf as to our (the American physician) ignorance of Boveri's contribution to the biology and cytology of cancer, prompt a reply. All students of the biologic sciences, including those who happen to be physicians, are no doubt aware of the contribution by Boveri, which appeared some years ago and is largely lost and forgotten in the mass of later contributions to our knowledge (or perhaps lack of knowledge) of cancer. Boveri

called especial attention to the deviations from the normal in the mitotic changes in the cancer tissue cells. But Dr. Metcalf's statement, "Boveri's studies of double fertilized sea-urchin eggs established the probability that human and other animal cancer is essentially a distortion of the numerical relations of the chromosomes in the cell," must not be construed as an opinion by Boveri himself. Boveri merely called attention to the peculiar chromosome figures in cancer tissue, an observation verified by every *student* of cancer since then. Particularly striking are these figures in the sarcomas of the young.

Anyway, the important thing is, what is the cause of cancer and how may it be controlled or prevented? It is rather deplorable that Professor Metcalf's search, "extending over fifteen years," has not brought to light one American physician who knew of Boveri's researches.

ALBERT SCHNEIDER
NORTH PACIFIC COLLEGE OF OREGON,
PORTLAND, OREGON

THE AVOCADO AND VITAMINS

IN a recent pamphlet entitled "Calmin Avocado Orchards," distributed by the Calmin Mortgage Corporation of Fallbrook, California, it is stated, in regard to the avocado (page 15) that "Vitamin C is also found in liberal quantities."

In a series of twelve guinea pigs, of various weights, fed in our laboratory on a diet of avocado mash, oats and water, all the animals but two developed some of the typical lesions of scurvy within twenty-six days. All the animals died toward the end of the third week, or in the fourth week, of the disease, save the two dying at twelve and fifteen days of bronchopneumonia, these two showing no evidence of scurvy. The average daily intake of avocado mash varied between three to six gm. for one hundred gm. of initial body weight. No relation was noted between the amount taken and the severity of the lesions. Four control animals, fed on oats and water, also developed the signs and lesions of scurvy during the third and fourth week, at about the time scurvy usually appears in laboratory animals.

Santos (*Amer. Jour. Phys.*, 1922, 59: 310–334) found the avocado, a fruit that is eaten raw, to be relatively high in vitamin B. He also endeavored to determine the vitamin C content, realizing the practical value of this vitamin in foods that are palatable in the raw state, but he was unable to get the guinea pigs to eat the fruit.

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STANFORD MEDICAL SCHOOL,
SAN FRANCISCO, CALIFORNIA

THE VELOCITY OF GRAVITATION

IN SCIENCE for November 26 on page 525 a method is described for measuring the velocity of propagation of gravitational potential. I wish to point out that this method can not give the result desired because the apparent motion of the sun in its diurnal arc is due to the rotation of the earth. The experiment proposes to find the local apparent time of the maximum vertical component of the sun's gravitational attraction as measured on a delicate balance. But since this attraction is a continuous process (as is the emission of radiation from the sun) the maximum vertical component must necessarily occur when the sun is on the meridian, that is, at local apparent noon, whatever the velocity of gravitation may be.

Although the speed of light is finite, the real sun is of course directly on the meridian when we see it there, and would be there no matter what the speed of light might be.

CARL T. CHASE

"METABOLOGY"

DR. MAX KAHN has added three words to the vocabulary of metabolism which have since been incorporated in the standard medical dictionaries. They are: "eubolism," "dysbolism," "pathobolism" (SCIENCE, June 20, 1922).

The growth and study of metabolism has progressed so much that I believe the vocabulary can be increased by the addition of the term *"metabology,"* or the study of metabolic processes in the organism. This word does not appear in current medical dictionaries.

MORRIS H. KAHN

SCIENTIFIC BOOKS

Aeronautical Meteorology. By WILLIS RAY GREGG, A.B., meteorologist, U. S. Weather Bureau, fellow American Meteorological Society, fellow Royal Meteorological Society, Ronald Aeronautic Library, C. de F. Chandler, Editor. The Ronald Press, New York, 144 pages, XI plates, 33 figures. Price, $2.50.

THE editor of this library series remarks that we need progressive literature of aerial navigation, technical information for designers, engineers, pilots and the growing army of students. This is all true, but at the present time much more is written about the machine than about the medium in which the machine is to function; that is to say, study of the air itself is subordinated to study of the airplane. Perhaps this is proper; but the reviewer for one is glad to

see a book giving information on the behavior of the air, for the benefit of airmen. There can be no doubt of the utility of such a volume, and both the editor and Mr. Gregg are to be congratulated on the publication of a book that for the present meets the need. There is no valid reason why every pilot should not be well versed or at least fairly familiar with the more frequent types of air structure, the processes of cloudy condensation, the formation of fogs, ice-storms, hail-storms and thunder-storms, the shift of wind direction with increasing height, the significance of a change in velocity, the nature of a zone of discontinuity and what it portends, the frequency of favoring and unfavoring winds, the average height of clouds, the meaning of each type and its growth or dissipation; and in short, as much as possible of what Sir Napier Shaw calls "The Air and its Ways," with particular emphasis on the "ways." We group them all under the general term aerography—the science of air structure. No land explorer should be without a knowledge of geography, no seaman scorn a knowledge of hydrography, neither should a flier be without a knowledge of aerography.

There have been decided changes in our knowledge of the structure of cyclones and anticyclones. By persistent recurrence to his idea of thermal stratification of the atmosphere, Shaw has brought us to new conceptions of cyclonic structure, and we now rule out former notions of inrushing, rising warm air and the condensation of vapor, as the prime movers in a cyclone, and on the other hands descending dry cold currents as the essential feature of an anticyclone. This old idea of a cyclone, says Dr. Simpson (Address, Section A, British Association for the Advancement of Science, August, 1925) was tersely expressed by Sir Oliver Lodge in a letter to the *Times* last year, as follows:

> A cylindrical vortex with its axis nearly vertical rolling along at a rate conjecturally dependent partly upon the tilt and with an axial uprush of air to fill up a central depression which depression nevertheless was maintained and might be intensified by the whirl, the energy being derived from the condensation of vapor.

But unfortunately for the theory, observation does not sustain it. The air does not move in a continuous spiral, and there are decided discrepancies in the distribution of temperature. Air streams are discontinuous and seem to retain their temperatures. Rain does not fall where it should according to schedule; and so we come to explanations based more upon energy derived from readjustment of the center of gravity of the air mass as a whole, the whole being made up of blocks of air of diverse origins.

Here is where observations in strata one thousand meters and more above the earth become so important, and where knowledge of the vertical structure lets us understand what is really taking place. The diurnal range of temperature, for example, so characteristic of surface readings, fades out at about one kilometer.

Gregg gives with some detail charts showing average temperatures, pressures and densities at the 3 km level, for the United States, east of the Rocky Mountains.

The chapters which most directly bear upon aviation are those on the "Winds" (Chapter IV), and Chapter IX on "Forecasting."

At the surface the air does not flow parallel to the isobars because of friction and viscosity, so that one must rise about five hundred meters to find the gradient wind, or wind parallel to the isobars. But the gradients aloft may be and generally are not in close agreement with surface readings, hence the winds will also change in direction and intensity.

The shifting of winds with altitude into a westerly quarter is shown in detail. With regard to changes in velocity, it is shown that there is a marked increase from the surface up to five hundred meters, then a more gradual increase, and decided seasonal variation in the upper levels.

At usual flying levels the wind factor is 3.5 meters per second; and in the author's opinion it is now possible to fix schedules for aircraft that can be guaranteed any desired percentage of the time—so far as winds are concerned.

There are some good reproductions of cloud photographs. The typography and general make-up reflect credit upon the Ronald Press Company.

ALEXANDER MCADIE

SPECIAL ARTICLES

THE EFFECT OF SODIUM SILICOFLUORIDE SPRAYS ON THE PEACH AND ON THE CONTROL OF BACTERIAL SPOT

SOME preliminary experiments by the writer during the summer of 1925[1,2] indicated that sodium silicofluoride in dilute solution (two pounds to fifty gallons of water) had a decided effect in checking the bacterial spot of peach on the leaves. Unfortunately there was no fruit on the trees, and it was not until the summer of 1926 that the action of this chemical on the fruit could be studied. The results this year confirmed those of 1925 in so far as control of the disease was concerned and interesting information on a unique effect on the fruit was secured.

[1] *Phytopath.* 16: 79–80, 1926.

[2] Trans. Ill. Hort. Soc. 59: 266–272, 1926.

EFFECT ON FRUIT

Spraying experiments were conducted in two widely separated orchards, one in central Illinois and the other in the extreme south part. The results obtained were quite similar so far as the effect on the foliage and fruit was concerned.

No injurious effect was noted on the fruit until shortly before harvest and even then no burning or marking of the fruit could be seen. It was observed, however, that the fruit on all the sodium silicofluoride plots ripened from four to six days ahead of that on unsprayed plots or on those sprayed with dry-mix lime and sulfur. In addition, the fruit had a higher color and was somewhat smaller. At the tip was an area varying considerably in size and shape with a color range from dark green to yellowish green. These areas were conspicuous in contrast to the deep red and light yellow of the surrounding portion. The taste of the entire fruit was insipid and in some cases rather bitter. Cracking was somewhat more marked on the sodium silicofluoride plots than on the others, but this might have been due in part to the difference in the time of ripening. A similar effect on the peach was observed by Mr. R. L. McMunn, of the Department of Horticulture, in 1924 on some trees sprayed with Flu-Sul. This is a commercial product containing barium fluoride as one of the active ingredients.

EFFECT ON FOLIAGE

The effect of the sprays containing sodium silicofluoride on the leaves varied somewhat throughout the season. On the whole little injury was observed although rather severe burning at the tips and along the edge occurred on some trees. This could not be correlated with temperature or other weather conditions and was never serious enough to cause alarm. At the end of the season the trees, however, were in as good condition as those sprayed with other materials.

CONTROL OF BACTERIAL SPOT

At Urbana, where the spray applications were made at weekly intervals starting June 21 and continuing until July 26, almost perfect control on the fruit was secured. The checks received a "shuck" spray of lead arsenate and lime, but no other sprays. The fruit was harvested the latter part of August and all the peaches were examined from five sprayed trees and three check trees. On the sprayed trees 0.48 per cent. of the fruit was diseased, while on the check 86.7 per cent. showed serious spotting.

At Ozark, Illinois, where the sprays were applied at ten-day intervals, starting with the "shuck" spray, the sprayed trees showed 11.5 per cent. diseased fruit, while an unsprayed check had 69.5 per cent. diseased peaches. On a sulfur-lime-dusted plot the percentage of spotted fruit was even higher than on the check, while on a dry-mix sulfur lime plot 65 per cent. of the fruit was diseased. The control of the disease on the leaves was not as successful as that on the fruit. At Urbana, where careful counts were made, the sprayed trees had 38.3 per cent., while the checks had 84.5 per cent. diseased leaves.

In spite of the fact that both in 1925 and 1926 the southern peach-growing sections suffered from severe droughts during the spring and early summer, leaf spot was unusually severe. This, together with numerous other observations, tends to support the theory that the bacteria are carried to the leaves and fruit in dust particles. It has been proved[3] that the pathogen can survive the winter in dead leaves and that the bacteria are extremely resistant to desiccation. It would seem logical, therefore, to account for the widespread infections in dry seasons by assuming that the dust arising during the process of cultivation and through high winds are responsible for conveying numerous bacteria to the leaves and fruit, where moisture from dew or light rains would give them a chance to enter the stomates and bring about infection.

Sodium silicofluoride sprays in a schedule starting with shuck fall gave much better results than when started a month later, although the disease did not become evident until much later. It seems possible, therefore, that the bacteria in the dust particles may be present for some time on the fruit and leaves without bringing about infection and that the sodium silicofluoride solution kills the bacteria when the particles of dust become moist enough to start the activity of the bacteria.

It is not considered safe for the growers to use any spray containing sodium silicofluoride until further experiments are made as to the effect of different climatic conditions on the amount of injury. Also, further work must be done on determining the chemical changes which take place after the material is applied to the trees.

The sodium silicofluoride used in these experiments was kindly donated by Jungmann and Company, of New York, and was known as their "L & V" commercial sodium silicofluoride. While this material upon analysis proved to be remarkably pure for a commercial product the recent article by Roark[4] indicates that chemical reactions taking place during mixing and application will change the composition

[3] Anderson, H. W., "Overwintering of Bacterium Pruni," *Phytopath.* 16: 55–58, 1926.

[4] Roark, R. C., "Fluorides *vs.* Silicofluorides as Insecticides," SCIENCE 63: 431–432, 1926.

of the substance. No attempt has been made to determine the exact chemical composition of the product after being deposited on the leaves and fruit.

H. W. ANDERSON

UNIVERSITY OF ILLINOIS

A COMPARISON OF THE VISCOSITY AND LIQUEFACTION OF VARIOUS GELATINS

A STUDY of a few brands of gelatin in their relation to the ability of bacteria to liquefy them was undertaken to determine the suitability of the gelatin on the market for use in bacteriological work.

The gelatin media employed consisted of

Peptone (Difco)	0.1 gram
Gelatin	various amounts
Water (distilled)	100 cc.

This was heated at 60 to 65 degrees C. till dissolved, the reaction adjusted to pH 7.4 and sterilized at fifteen pounds for fifteen minutes.

The viscosity of three of these gelatins as shown by the Ostwald viscosimeter was as follows:

Gelatin 2 per cent.	Viscosity (36° C.) Referred to water
No. 1	1.66
No. 2	1.396
No. 3	1.475

Gelatin 10 per cent. in culture tubes was inoculated with one tenth cc of a broth culture of Serratia marcescens and incubated at 20 degrees C. The depth of the liquefaction was measured each day.

	Days					
Gel no.	1	2	3	4	5	6
	Centimeters					
1	.5	1.	1.2	1.5	1.8	2.4
2	1.	2.4	3.2	4.6	complete liquefaction	
3	.6	.9	1.6	2.2	2.8	3.

The liquefaction of gelatin No. 2 would be rated as rapid, while that of No. 1 would be comparatively slow. This No. 2 gelatin was not less than eighteen years old at the time of the experiment. The Digestive Ferments Company gives the information that the present-day gelatins have considerably more gelation power than those of twenty years ago. The liquefaction of gelatin by bacteria observed twenty years or more ago should be deduced on this basis.

It is generally understood that the age of the gelatin culture medium is a factor in the liquefaction time; that is, a gelatinolytic organism may bring about liquefaction quite rapidly when inoculated into freshly prepared gelatin, and much more slowly if introduced into the same medium sometime later. This is based on the observation that the viscosity of gelatin increases with age.

That the viscosity increase due to age does not affect the liquefaction rate is shown below.

Gelatin culture medium inoculated with one tenth cc of a broth culture of Proteus vulgaris. Incubated at 20 C.

	Gelatin one day old			Gelatin twenty days old		
	15 per cent.	10 per cent.	5 per cent.	15 per cent.	10 per cent.	5 per cent.
24 hrs.	2 mm	2 mm	5 mm	2 mm	2 mm	5 mm
48 hrs.	4 mm	5 mm	15 mm	4 mm	5 mm	15 mm
72 hrs.	6 mm	8 mm	20 mm	6 mm	8 mm	20 mm

FREDERICK W. SHAW

MEDICAL COLLEGE OF VIRGINIA,
RICHMOND

THE OKLAHOMA ACADEMY OF SCIENCE

THE fifteenth annual meeting of the Oklahoma Academy of Science was held in Stillwater with the Oklahoma A. and M. College, November 26 and 27. This meeting was held under the presidency of J. H. Cloud, professor of physics, O. A. M. C.

One hundred and eleven papers were presented. These included 54 papers in the section of biology, 21 geological papers, 16 papers in physical science and 17 in social science. Three general addresses were also given.

The Oklahoma division of the American Chemical Society met in conjunction with section C, the section of physical sciences.

Officers for the year 1927 were chosen as follows:

President, Charles N. Gould, of Oklahoma Geological Survey.

Assistant Secretary-Treasurer, Herbert Patterson, O. A. M. C.

Vice President, Section A, L. B. Nice, University of Oklahoma.

Assistant Vice President, Section A, Robert Stratton, O. A. M. C.

Vice President, Section B, A. H. Koschmann, O. A. M. C.

Vice President, Section C., F. E. Knowles, Phillips University.

Vice President, Section D, J. Dowd, University of Oklahoma.

The membership at the time of the meeting was 173, of whom 62 are also members of the American Association for the Advancement of Science. At this meeting 95 new members were elected.

The activities of the academy are expanding very rapidly and its influence is of increasing importance.

A. RICHARDS,
Secretary-Treasurer.